down against the hot surface and stirred until a uniform glutinous mass is obtained. Then the proper weight of vaseline should be added, and the whole thoroughly stirred together.

This may be left on an air-pump plate for at any rate a couple of years without perceptible alteration either in itself or the brass. H. G. MADAN
Eton College

Butterflies' Wings

CAN you inform me of any method of relaxing the wings of butterflies allowed to stiffen in the closed state?
Stretford, Manchester, July 1 J. M. B.

[If the butterflies are laid on damp sand under cover of a bell-glass or other air-tight covering they will soon relax so as to be fit for setting-out. A drop or two of carbolic acid on a sponge should be placed with them in order to prevent mouldiness. —ED.]

NOTE ON THE ABSORPTION SPECTRUM OF DIDYMIUM

IN a paper on "Radiant Matter Spectroscopy" (Part 2, Samarium),[1] I said that in fractionation of the didymium earths with ammonia—"After a time a balance seemed to be established between the affinities at work, when the earths would appear in the same proportion in the precipitate and in the solution. At this stage they were thrown down by ammonia, and the precipitated earths set aside to be worked up by the fusion of their anhydrous nitrates so as to alter the ratio between them, when fractionation by ammonia could be again employed."

That in most methods of fractionation a rough sort of balance of affinities beyond which further separation by the same method is difficult, appears to be a general rule. I have long noticed this action when fractionating with ammonia, with oxalic and nitric acids, and with formic acid. The valuable point which renders this fact noteworthy is that the balance of affinities revealed by fractionation is not the same with each method. It was in consequence of the experience gained in these different methods of fractionation that I wrote in my paper read before the Royal Society, June 10 last (*Chemical News*, vol. liv. p. 13), after saying that I had not been able to separate didymium into Dr. Auer's two earths, "probably didymium will be found to split up in more than one direction according to the method adopted."

In illustration of this I may mention that, although I have not split up didymium into the two earths, or groups of earths, which are described by Dr. Auer, other processes of fractionation give me, so to speak, other cleavage planes or lines of scission through the compound molecule didymium.

According to Dr. Auer, a line in the well-known yellow band, close to the soda line, but less refrangible (w.l. about 579), is a component of the absorption-spectrum of neodymium, and therefore, under all conditions, its intensity should follow the same variations as the other bands of neodymium in the blue (wave-lengths 482, 469, 444). Some of my didymium fractions, however, show that the line 579 does not follow the same law as the other bands I have named. Thus, in a rather low fraction (+ 6) of the didymium earths from gadolinite and samarskite I found that the neodymium line 579 was of the same degree of blackness as the adjacent praseodymium line in the yellow (wave-length about 571), but the bands in the blue of neodymium had almost disappeared. In the adjacent fractions of didymium I was enabled, by appropriate dilution, to keep this set of bands in the yellow as a standard, of exactly the same intensity ; it was now seen that in successive fractions the intensities of the other more refrangible lines belonging both to neo-

[1] *Phil. Trans.*, Part 2, 1885, p. 706. A reprint of this paper is also commenced in No. 1390 of the *Chemical News*, p. 28.

and praseodymium varied greatly from strong to almost obliteration, the bands in the yellow always being kept of the same intensity.

Didymium prepared from a specimen of fluocerite differed somewhat from the other didymiums. Here the band 579 (ascribed to neodymium) was very strong, the band in the yellow of praseodymium (571) slightly weaker, and the bands in the blue of neodymium (482, 469, and 444) easily visible. On diluting the solution the bands in the blue of neodymium and the one component of praseodymium in the yellow (571) appeared to follow the same law in becoming fainter and fainter with dilution, whilst the other component band in the yellow of neodymium (579) remained unaffected.

It seems to me that a possible explanation of this variation might be founded on the great strength of the bands in the yellow, and that the two fractions of didymium then under examination might differ only in the fact that one was slightly stronger than the other. To test this hypothesis I took the two fractions first experimented on, and putting each into a wedge-shaped cell of glass viewed them together in the spectroscope. (1) I adjusted the wedges so that the group in the yellow appeared to be of the same intensity in each spectrum. On examining other parts of the spectrum it was seen that in one solution the bands in the green were tolerably strong, and the bands in the blue scarcely visible, whilst in the other solution the bands in the green were very faint, and those in the blue quite absent. (2) The position of the wedges was adjusted so that the bands in the green in each case should be of equal intensities. It was now seen that the alteration had greatly upset the balance of the bands in the yellow, the solution in which the bands in the green were faintest before, now having much stronger yellow bands than the other. The explanation mentioned above therefore falls through, and I see no other way of accounting for the facts except in the supposition that by the mode of fractionation then adopted, didymium had split up in a different manner to what it would have done if the method of Dr. Auer had been followed.

The colour of the different fractions of didymium nitrate varies from a dark rose-red at the more basic end (+ 17) to amber at the less basic end (+ 4). These variations in colour do not necessarily accompany a difference in the absorption-bands, for in one instance an amber and a rose-coloured salt were found to have almost identical spectra.

It would almost appear from these experiments, coupled with the facts I brought forward in last week's *Chemical News* (p. 14), that the "one band, one element" theory I lately advanced in connection with the phosphorescent spectrum of yttrium, may probably hold good in the case of the group of elements forming absorption spectra. According to this hypothesis, therefore, neodymium and praseodymium must not be considered as actual chemical elements, but only the names given to two groups of molecules into which the complex molecule didymium splits up by one particular method of fractionation.

WILLIAM CROOKES

HEATING AND COOKING BY GAS

A FEW years ago the public was led to believe that the use of coal-gas for lighting purposes was on its trial, and must shortly give way to the electric light. Threatened institutions live long, and even if coal-gas is destined to be eventually superseded by electricity for lighting purposes, a useful future is now opening out for it as a fuel offering many advantages over coal for domestic heating and cooking. In these fields it may possibly occur in the future that coal-gas—unless the price is everywhere considerably reduced—will have to encounter rivals such as the petroleum oils on the score of their cheapness, but at present, coal-gas, for cooking

and heating purposes, offers many facilities and advantages over any other kind of fuel.

Gas Cooking Stoves.—Those who remember the gas cooking stoves which were offered to the public even a few years ago, will acknowledge that the modern stoves now manufactured have reached a very high degree of perfection. In nearly all the larger kinds of stove intended for a family of six or more persons, the sides and top of the oven are constructed of double walls, and packed with a non-conducting fire-proof material— generally slag wool—so that but little heat escapes from the exterior of the stove to be lost by radiation ; the internal surfaces of the stoves are usually enamelled, and are thus preserved from rust and decay, and easily kept clean, and in addition in some ovens, the racks for suspending the grids from which the meat is hung, slide out or turn out on a hinge, and are thus more easily cleaned than when fixed in the oven. On the tops of the stoves are placed burners for boiling kettles and saucepans, and for stewing, and an invertible burner is sometimes added, which can be rotated so as to bring the flame underneath when it is intended to grill. The following points may be enumerated as those in which cooking by gas possesses decided advantages over the ordinary kitchen range :—(1) There are no dust or cinders, and the whole process is more cleanly ; (2) in some of the best stoves the oven can be heated up to a high temperature—sufficient for making pastry—in a few minutes only after the gas is lighted ; (3) the different degrees of heat necessary for cooking various articles can be easily attained by limiting or increasing the supply of gas to the oven burners, or by increasing or diminishing the ventilation of the oven by opening or closing the flue-valve ; and this is a point which good cooks will especially appreciate.

The principal arguments adduced by the opponents of gas cooking may be stated to be :—(1) That the cost is greater ; (2) that joints of meat baked in gas ovens smell or taste of gas ; (3) that the fumes and smell of cooking are more perceptible from gas ovens than from ordinary kitchen ranges ; (4) that there is no supply of hot water with a gas oven ; (5) that the gas stove does not warm the kitchen. We will now proceed to consider these objections *seriatim.*

(1) Although there can be no doubt that more heat is obtained from coal by burning the same value than from gas, still if attention is paid to the stove, and the gas is turned off as soon as the cooking is finished, for ordinary sized households the difference in cost between cooking by gas and cooking by coal is hardly appreciable.

(2) We may class gas ovens as of two kinds, A and B. In A, rings or rows of burners are placed at the bottom of the oven, and the air of the oven is heated up, this heated air and the products of combustion of the gas passing over and baking the meat. The burners used are usually those which give a luminous flame, for the reason that the luminous flame, although not itself of so high a temperature as the non-luminous flame from the atmospheric burner, yet radiates more heat. This greater radiation of heat is, like the luminosity, due to the separation of solid particles of carbon in the flame which become incandescent. Thus we see that the luminous flame radiates more heat to the air of the oven than the non-luminous. But it is in this class of oven especially that the baked meat smells or tastes of gas, as it is liable to become sodden with the steam and other products of combustion of the gas jets which pass over it, and no amount of ventilation of the oven will entirely cure this defect. In the other class of ovens, B, the burners are placed in rows at the bottom and along the sides of the oven walls. The oven walls are heated by the flames, and when hot radiate the heat to the joint of meat, which is thus baked by radiant heat as well as by hot air. The products of combustion of the gas jets pass up the sides of the oven and escape by the flue at the back without contaminating the meat. Atmospheric burners are almost invariably used in this class of oven, because the non-luminous flame is hotter than the luminous, and more quickly heats the oven wall, although less heat is radiated from the flame itself. The atmospheric burners have also this advantage, that the gas being mixed with twice its volume of air, the hydrogen and carbon are burnt at the same time, and no solid particles of carbon are formed, and thus there can be no soot from imperfect combustion, as so often happens in the luminous flame, in which the hydrogen of the hydrocarbons burns before the carbon, which is separated into small solid particles and strongly heated up before being finally burnt to carbonic acid. Consequently meat baked in this class of oven is not distinguishable from a joint roasted before an open fire.

(3) If a flue is carried up from the top of the back part of the oven into the kitchen chimney, the fumes from the oven cannot enter the general air of the kitchen. In all gas apparatus of whatever sort, some means must be provided for carrying off the products of combustion of the gas, and this is especially necessary in the case of gas cooking stoves. Ventilation of the oven is obtained by air passing in from below to ascend and escape with the products of combustion by the flue. The valve guarding the flue outlet is capable of regulating the ventilation, and is usually so constructed that it cannot entirely close the flue.

(4) The larger gas cooking stoves are now very usually supplied with boilers, which can be attached to the side of the stove, and can be heated below by a ring of atmospheric burners. [The burners at the top of the stove for boiling kettles and saucepans, making toast, grilling, and stewing, should also be atmospheric.] There can be no doubt that for heating a large supply of water, gas is not economical as compared with coal, but these boilers have this great advantage that they can be easily inspected and cleaned, and the fur—caused by the deposit of lime salts where the water to be heated is hard—can be easily removed. In towns and districts which are supplied with hard water (containing much carbonate of lime in solution), the ordinary kitchen boiler must be opened occasionally to remove the fur—a proceeding causing much inconvenience. If the fur deposit is allowed to accumulate too long an explosion may take place. This may happen in one of two ways ; either the mouth of the supply pipe may become choked, cutting off the water from the boiler, or the boiler plates having become much heated, whilst the water in the boiler is cool owing to the intervention of a thick non-conducting layer of fur, if this deposit should crack, the cold water coming suddenly into contact with the red hot iron would cause a dangerous evolution of steam. The boilers sent out with gas cooking stoves can supply hot water for the kitchen only ; they are not made to give a hot water supply under pressure available at any part of the house, as is the ordinary kitchen high-pressure boiler, so that for upstairs bath and lavatory purposes, hot water must be obtained from some form of gas bath-heater, of which we will speak presently.

(5) The gas stoves now made—being well packed and losing but little heat by radiation—certainly do not warm the general air of the kitchen as the kitchen fire does, and this negative quality in summer is a great advantage, as the kitchen remains cool instead of being at the usual unbearable temperature. In winter. if the kitchen fire is retained, this should be lighted early in the day until the room is warm, or some form of gas fire may be used—or it is even possible now to obtain a gas stove combining an open gas fire below, in front of which a small joint may be roasted, with a small gas oven above. The open gas fire will sufficiently warm a small kitchen.

The consumption of gas in a stove of the size required for a family of nine or ten persons varies from 15 to 20 cubic feet per hour (at an average pressure of 8/10) if the

oven burners alone are lighted and turned full on. In most cooking operations the amount of gas required would be only two-thirds of these quantities; the supply of gas being easily regulated to this or any other amount. If all the top burners in addition be lighted and turned full on, the average run of gas is from 40 to 60 cubic feet per hour. Twenty feet an hour for six hours a day is a fair representation of the amount of cooking required in a middle class family of ten persons. At 3s. per 1,000 cubic feet, this would entail an expenditure of 4·32d. per day, or 2s. 6¼d. per week, or 1l. 12s. 9¼d. per quarter. To raise a gallon of water in a copper boiler from 50° F. to 170° F., requires on the average a consumption of about 3 feet of gas, so that if very much hot water is required for culinary or domestic purposes the gas bill may be expected to show a corresponding increase.

Cooking by gas will not be introduced all at once. Gas stoves are now very generally obtained to supplement the kitchen range, for which purpose they are excellently adapted; and as their possibilities and advantages are more clearly appreciated they will no doubt come into more general use. We have indicated some of the chief points in their construction and management, and while we do not advise any one utterly to discard coal fires for cooking, we would recommend a trial of gas as being likely, where it can be obtained of good quality at moderate prices, and where the stoves will be treated with care and attention, to be found economical, cleanly, and useful.

Water and Bath-heaters.—In a house where gas is entirely used for heating and cooking, or where there is no high-pressure kitchen boiler connected with a hot water cistern by circulating pipes, capable of giving a supply of hot water on the upper floors, one of these appliances will be found very useful. There are numerous forms of this apparatus, and most of them are contrived in a very ingenious manner. The plan usually adopted is to receive the cold water at the top of the apparatus—which is of copper or copper tin-lined—where it is spread out in the form of spray or thin films to pass slowly down over surfaces of copper, receiving in its passage the necessary heat from gas burners below, to the bottom of the apparatus, where it flows out by a spout. The temperature of the issuing water will vary with the quantity of gas consumed and with the flow of the water, *i.e.* the amount passing through the apparatus in a given time. The object generally aimed at is to obtain a bath of 30 gallons of water at 100° F. in twenty minutes or thereabouts. For this purpose the water must be heated to about 105°, as when in the bath it gradually cools whilst this is filling. In the best forms of bath-heater, 25 to 30 cubic feet of gas must be consumed—at ordinary pressures, 7/10 to 10/10—to raise 30 gallons of water from 50° to 100° in 15 or 20 minutes. Here then we have an apparatus which at the cost of little more than 1d. is capable of providing ample material for a good warm bath. We would unhesitatingly recommend these bath-heaters, were it not the custom of most of the makers—with one or two exceptions however—to send them out without any flues or chimneys, and even sometimes to assert that no flue is necessary, as there is no smoke, and nothing unpleasant is produced by the combustion of the gas. There have however been some very unpleasant consequences from taking a bath in a small highly heated room, the air of which was loaded with carbonic acid—fainting and even partial asphyxia having been recorded under these circumstances. That the danger is no imaginary one will be seen when we consider that if in a room containing 500 cubic feet of space—the size of very many bath rooms—50 cubic feet of carbonic acid are produced by burning 25 cubic feet of coal-gas, the percentage of carbonic acid in the air is raised from ·04 to 10, and the entire oxygen of 200 cubic feet of air is destroyed. Fatal results have been known from the inhalation, even

for a short period, of air containing 10 per cent. of carbonic acid. The temperature of the air of the room will also be very much raised, and will tend to help in the production of perhaps fatal syncope. We cannot then too strongly insist on the absolute necessity of providing a flue to carry off the products of combustion to the outer air of an apparatus which can produce such an enormous volume of carbonic acid in so short a space of time. The flue should be carried into a chimney with a good draught, as the escaping products are generally much cooled down by having parted with much of their heat to the water flowing through the apparatus. There are other varieties of water-heater constructed for various purposes, only one of which we are able to notice in the present article. This is a spiral water-heater for lavatories, the invention of Mr. Fletcher. In two minutes this little apparatus, at a cost of half a foot of gas, can raise nearly two quarts of water to 100° F. It is an ingenious contrivance, and free from the objections attending most of the larger apparatus described above.

Gas Fires.—These may be classified as radiation stoves, the room being heated entirely by radiation; and ventilation stoves, warm air issuing from the stove and displacing the colder air of the room. But many of these latter also warm the room by radiation from the incandescent asbestos or from the warm sides of the stove. Mr. Fletcher has calculated that with gas at 3s. per 1000 cubic feet, his open incandescent radiation gas fires cost for the same work about as much as coal fires when the coal is 30s. per ton, but with ventilating stoves the cost is about two-thirds of this. As in cooking by gas however, there are no dust, dirt, or cinders, and the fire can be immediately lighted or extinguished and requires no attention when alight. Nearly all the patterns of radiation stove now made depend on the heating of fibre or lump asbestos by non-luminous flames from atmospheric burners. The average consumption of gas required to maintain a room containing 5000 or 6000 cubic feet of space at a suitable temperature in winter, varies between 12 to 20 cubic feet per hour, depending on a large variety of circumstances. Most people when sitting in a room prefer to be warmed by radiant heat, as from an ordinary open coal fire, and to leave the ventilation of the room to accidental circumstances—which usually means a cold draught along the floor towards the fire. Ventilation stoves, if they fulfil the proper conditions, are certainly better adapted for warming large apartments, such as shops, workrooms, and halls, than radiation stoves. The conditions to be fulfilled are that the air be taken from a pure source in the outer atmosphere, that it be warmed by its passage through the stove, but not overheated or burnt—as is so often the case—and that it enter the room in an ascending direction towards the ceiling. In many cases it may be necessary that the air, rendered dry by its passage through the stove, should be moistened by passing over a tray of water before entering the general air of the room. Radiation stoves are perhaps better suited for private houses, especially for bed rooms and other apartments where a fire is only occasionally required. The flues of these stoves should open into the chimney at the back of the fireplace. The temperature of the air and products of combustion escaping through the flue will generally be found very high, but the heat thus lost is necessary to create a draught up the chimney, and assists in the ventilation of the room.

It has been said that the more general adoption of gas for heating and cooking would solve the smoke difficulty in London and those large towns where domestic and not factory smoke is the chief offender. A London pea-soup fog is certainly due to the coating of the particles of moisture suspended in the mist with "a carbonaceous sulphurous cuticle" as Mr. Harold Dixon has expressed it, and by preventing the daily evolution of millions of small particles of unconsumed carbon from our chimneys, we

should do away with the acrid yellow character of our fogs. But the mists due to the position of London on the estuary of a large river, would remain to the same extent as now, and there would still be the same amount of sulphurous acid given off into the air to be precipitated with the rain as sulphuric acid, and carry on its work of destruction on building stones and mortar. One cubic foot of coal-gas produces on combustion 0·2 to 0·5 grains of sulphurous acid, so that the amount evolved would continue to be, as now, enormous. Still the air would be deprived of its sooty particles to a great extent, and the old familiar features, characteristic of grimy London, might in time disappear. The carbonic acid which is the chief product in the combustion of coal-gas, is diffused at once into the general body of the atmosphere, and the marvellous rapidity with which this is effected is revealed to us when we know that the air of our open streets and parks differs only by the most minute quantities—if at all—in its contained carbonic acid, from the air of the mountains or the sea.

THE TOPOGRAPHIC FEATURES OF LAKE SHORES [1]

Introduction

THE play of meteoric agents on the surface of the land is universal, and there is a constant tendency to the production of the forms characteristic of their action. All other forms are of the nature of exceptions, and attract the attention of the observer as requiring explanation. The shapes wrought by atmospheric erosion are simple and symmetric, and need but to be enumerated to be recognised as the normal elements of the sculpture of the land. Along each drainage line there is a gradual and gradually increasing ascent from mouth to source, and this law of increasing acclivity applies to all branches as well as to the main stem. Between each pair of adjacent drainage lines is a ridge or hill standing about midway and rounded at the top. Wherever two ridges join there is a summit higher than the adjacent portion of either ridge; and the highest summits of all are those which, measuring along lines of drainage, are most remote from the ocean. The crests of the ridges are not horizontal, but undulate from summit to summit. There are no sharp contrasts of slope; the concave profiles of the drainage lines change their inclination little by little, and they merge by a gradual transition in the convex profiles of the crests and summits. The system of slopes thus succinctly indicated is established by atmospheric erosion under the general law of the interdependence of parts. It is the system which opposes the maximum resistance to the erosive agents.

The factor which most frequently, and in fact almost universally, interrupts these simple curves is heterogeneity of terrane or diversity of rock texture. Different rocks have different powers of resistance to erosion, and the system of declivities which, under the law of interdependence, adjusts itself to diversity of rock texture, is one involving diversity of form. Hard rocks survive, while the soft are eaten away. Peaks and cliffs are produced. Apices are often angular instead of rounded. Profiles exhibit abrupt changes of slope. Flat-topped ridges appear, and the distribution of maximum summits becomes in a measure independent of the length of drainage lines.

A second factor interrupting the continuity of erosion profiles is upheaval, and this produces its effect in two distinct ways. First, the general uprising of a broad tract of land affects the relation of the drainage to its point of discharge or to its base level, causing corrosion by streams to be more rapid than the general waste of the surface, and producing cañons and terraces. Second, a local uprising

by means of a fault produces a cliff at the margin of the uplifted tract, and above this cliff there is sometimes a terrace.

A third disturbing factor is glaciation, the *cirques* and moraines of which are distinct from anything wrought by pluvial erosion; and a fourth is found in eruption.

The products of all these agencies except the last have been occasionally confused with the phenomena of shores. The beach-lines of Glen Roy have been called river terraces. The cliffs of the Downs of England have been ascribed to shore waves. Glacial moraines in New Zealand have been interpreted as shore terraces. Beach ridges in our own country have been described as glacial moraines, and fault terraces as well as river terraces have been mistaken for shore marks. Nevertheless, the topographic features associated with shores are essentially distinct from all others; and when their peculiar characters are understood there is little occasion for confusion. It is only where the shore record is faintly drawn that any difficulty need arise in its interpretation. In investigating the history of Lake Bonneville and other Quaternary water bodies of the Great Basin, the writer and his assistants have had constant occasion to distinguish from all others the elements of topography having a littoral origin and have become familiar with the criteria of discrimination. Their endeavour to derive from the peculiarities of the old shore lines the elements of a chronology of the lake which wrought them, has led them to study also the genesis of each special feature. [1]

In the discussion of shore phenomena there is little room for originality. Not only has each of the elements which go to make up the topography of a shore been recognised as such, but its mode of origin has been ascertained. There appears, however, to be room for a systematic treatment of the subject in English, for it is only in continental Europe that its general discussion has been undertaken. The writings of Elie de Beaumont include a valuable contribution,[2] and Alessandro Cialdi has devoted a volume to the motion of waves and their action on coasts.[3] These cover a large portion of the ground of the present essay, but treat the subject from points of view so diverse that the essay would be only partially superseded by their translation. The title of a work by H. Keller ("Studien über die Gestaltung der Sandküsten") indicates another discussion of a general nature, but this I have not seen. American and British contributions are contained chiefly in the reports of engineers on works for the improvement of harbours and the defence of coasts. The most comprehensive which has fallen under my eye, and one, at the same time, of the highest scientific character, is contained in the annual report of the United States Coast Survey for 1869, where Prof. Henry Mitchell, in treating of the reclamation of tide lands, describes the formation of the barriers of sand and shingle by which these are separated from the ocean.

It is proper to add that the writer became acquainted with these works only after the body of this essay was prepared. The objective studies on which his conclusions are based had been completed, and the discussion had acquired nearly its present shape before he became aware of the extent of the affiliated literature. His conclusions have, therefore, the quality of independence, and, so far as they coincide with those of earlier writers, have a corroborative value.

The engineering works whose construction has led to local investigations of shores are chiefly upon maritime coasts, where tides exert an important influence, and the literature of lake shores is comparatively meagre. It is

[1] From a paper by Mr. G. K. Gilbert in the "Fifth Annual Report of the Geological Survey of the United States for 1883-84." (Washington, 1885.)

[1] Partial outlines of the subject have been presented by the writer in connection with various accounts of Lake Bonneville, and a fuller outline was published by Mr. I. C. Russell in a paper on Lake Lahontan in the "Third Annual Report of the Geological Survey."
[2] "Leçons de géologie pratique;" tome premier; septième leçon, "Levées de sable et de galet," pp. 221-52.
[3] "Sul moto ondoso del mare e su le correnti di esso specialmente su quelle littorali pel comm." Alessandro Cialdi. Roma, 1866.